Reprinted from "The Indian Forester", Vol. 136. No. 6, June, 2010

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THE INDIAN FORESTER

P.O. New Forest
DEHRA DUN (INDIA)

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Introduction

Tropical forests are the store house of many economically important species and therefore liable to overexploitation. When the human population was small, forests were plentiful and provided enough for people's basic needs. The increase in population and a shift from nomadic to settled livelihood resulted in forests being cleared for agriculture and habitation. Anthropogenic activities such as industrial exploitation, mining activities, release of forest land for developmental activities, urbanization etc. have led to further large-scale deforestation. Burgeoning population has accentuated the pressure on the forests (Ravindranath *et al.*, 2000). When the anthropic pressure is stronger, deciduous and hardy evergreen species become increasingly abundant. Degradation has caused complete substitution of the evergreen forest by secondary deciduous type (Bourgeon, 1998).

The immense potential of forest resources is slowly being realized with the discovery of two compounds hitherto unknown to science in common tropical plants found in Madagascar, *Catharanthus roseus* (Apocynaceae): Vinblastin and Vincristin. Using these two compounds to treat children's leukaemia, it has been possible to reduce the mortality rates in certain forms of this disease from 90% to just 10% (Nauman, 2001). India with an area of 3,267,500 sq. km situated in the Southern peninsula of the Asian continent, harbors a vegetation scattered over the entire country and exhibits diversification due to climatic, physiographic and biotic factors (Gamble, 1921, Ramaswamy *et al.*, 2001). Indigenous people with a historical continuity of resource use practices often possess a broad knowledge of the complex ecological systems in their own localities and they do develop a stake in conserving, and in some cases enhancing biodiversity. In Western Ghats, forest conservation in pre-colonial days went hand in hand with utilization. Hunting was subjected to many community regulations. However, following the British occupation, there was large-scale forest exploitation and vegetation transformation into commercial plantations of coffee, tea, wattle and *Eucalyptus* (Chandran, 1997). Post independence, industrialization and

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commercialization has played further havoc while agriculture has cleared up a lot of pristine forestland. Deforestation, degradation and subsequent desertification have led to a process of no return for trees. Therefore sustainable management of biodiversity and prevention of its loss are of paramount importance considering the severity of threats faced by the forests today. In this context, a study has been undertaken in 22 localities with varying degrees of human disturbance falling under evergreen-semievergreen to moist deciduous type. The aim of this paper is to bring out the following:

1. Floristic structure, composition and diversity of forests with varying degrees of human disturbance.
2. Need for conservation and different strategies for sustainable utilization of forest resources.

Material and Methods

Study site : The study area is situated a little interior to the eastern corridors of the great chain of Western Ghat ranges (Shimoga district, Karnataka) gradually climaxing into evergreen as one moves west. The area is a part of a larger study area in Linganamakki catchment region of Sharavathi river basin. It falls under two taluks - Sagar and Hosanagar (74°67'11" to 75°30'63" E and 13°77'08" to 14°7'27" N) of Shimoga district. In the past few decades, large areas under forests have been cleared for hydroelectric projects, plantations, mining and for agriculture. In the upper catchment area, the forests in eastern regions unlike those of western part are highly fragmented and being surrounded by human habitations. Many of the original evergreen and semi-evergreen forests are surviving as isolated forests administratively classified as minor forests, smaller state forest and bits of 'proper forests' under the category *Kans*. However, some larger forest patches of more than 3000 ha are also present. The same is the case with moist deciduous forests, which makes up most part of the Sagar taluk and to a lesser extent in Hosanagar taluk. Anthropic pressure increases more towards the densely populated eastern parts of the taluks where the human needs are not being paralleled with forest resources as both the taluks depend extensively on these forests for fuelwood and other resources. Hence, even the remaining forests are being gradually transformed into other landuse types.

Climate : Rainfall is highly seasonal, with most of the annual 2381.98 mm falling during June to October wet season. However, it decreases as one proceeds towards the east from the Ghats region (west). April is the hottest month with the mean daily maximum temperature 35.8°C and the mean minimum 22.2°C. In December the mean daily maximum temperature is 29.2 ° C and mean minimum 9 ° C.

Methods : To understand the floristic diversity in the region, a transect consisting of alternate 20 x 20 m quadrats were used for sampling the habitat. Transect length depended on the species composition and diversity. All the trees at or above 10 cm diameter at breast height (DBH) or 30 cm girth at breast height (GBH) were

enumerated at 1.3 m above ground, identified, or samples collected (whenever possible) if field identification was not possible and were pressed for herbaria for future identification. Other features like epiphytes, climbers, parasites, any disturbances like lopping, logging etc., were also noted. Canopy cover was noted and ground litter quantity was weighed. Shrubs (GBH less than 30 cm and height more than 1m) were enumerated in two shrub quadrats of 5 x 5 m laid diagonally inside 20 x 20 m quadrat. Inside each shrub quadrat two 1 x 1 m herb plots (height less than 1 m) were laid diagonally and studied. Also general information such as ground control points using a Global Positioning System (GPS), name of the locality, range, human activities such as lopping, logging, Non-Timber Forest Produce (NTFP), fuel and litter collections, fire incidence, grazing etc. were noted down.

Results

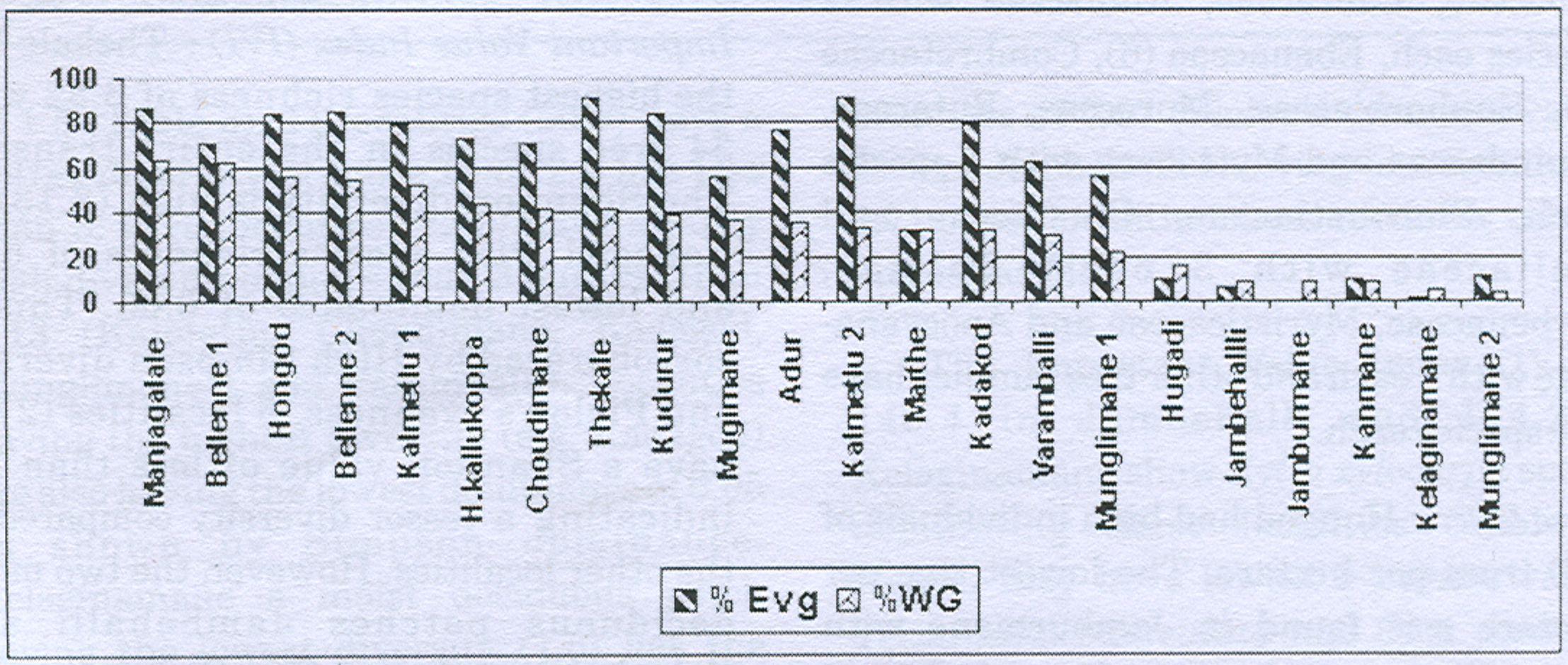
Floristics : Data analysis showed a total of 93 tree species, 20 climber species, 33 shrubs, 2 orchids, 13 herb species and 3 fern species (excluding those unidentified) distributed in 64 families and 136 genera

Table 1

Total number of Families, Genera and Species in entire study area.

Vegetation Layers	Families	Genera	Species
Tree layer	39	72	93
Shrub layer (Also includes tree juveniles)	45	86	109
Herb layer (Also includes tree and shrub seedlings)	52	107	129
Total (Trees, Shrubs and Herb layers)	64	136	166

Fig. 1



Percentage Evergreen (Evg) and Western Ghats Endemism (WG) in the study localities

(Table 1). Herb layer (inclusive of trees and shrub seedlings) had the highest number of families, genera and species of 52, 107 and 129 respectively followed by shrub (inclusive of tree saplings) and tree layer. The generic richness is highest in tree and shrub layers with genus *Diospyros* having 6 species, while herb layer has 5 species of *Diospyros*. However, when all the layers are considered *Diospyros* genus has 7 species. *Terminalia* follows this with 4 species in tree layer, *Holigarna* with 3 species in shrub layer and 3 species of *Canthium* in herb layer (includes tree and shrub seedlings). The highest percentage frequency of important tree families under all localities and vegetation types are Anacardiaceae (9.11), followed by Combretaceae (6.83), Lauraceae (6.6), Rubiaceae (6.6), Euphorbiaceae (5.4), Ebenaceae (5.2), Moraceae (5.0), Fabaceae (4.5), Meliaceae (4.5), Flacourtiaceae (4.3), Oleaceae (4.1), Cluseaceae (3.8), Lythraceae (3.18), Myristicaceae (3.18), Apocyanaceae (2.27), and all other families range below 1.82. In terms of the number of species the best represented families are Anacardiaceae, Fabaceae, Lauraceae, Rubiaceae with 7 species each, Ebenaceae (6), Combretaceae (5), Euphorbiaceae, Moraceae, Rutaceae, Sapindaceae and Myrtaceae with 4 species each, Flacourtiaceae, Clusiaceae and Meliaceae with 3 each, Palmae, Verbenaceae, Myristicaceae and Apocyanaceae with 2 each and other tree families have one species each.

Tree layer : Hongod had high individuals of 520 trees per hectare. The lowest tree per hectare was found in Jamburmane with only 188 trees per hectare. But this did not assure higher basal area for Hongod as seen from the Table 2 with Adur having the highest basal area of 50.4 with a medium of 370 individuals per hectare. Kalmetlu and Munglimane follow this. Varamballi has a very low basal area of 15.6 inspite of having a higher total individual per hectare than Jambehalli and Jamburmane. Other localities like, Bellene-2 and Maithe have a lower basal area compared to their higher total individuals than Adur.

A total of 26 endemic species are found with 25% endemism. Percentage of evergreen (PEv) is as high as 92.06 in Thekale and 90.9 in Kalmetlu-2 but with a lower percentage endemics (PEn). PEv occurs in varying degrees in other localities, obviously lowest in most of the moist deciduous forests as shown in Figure 1. High PEn is seen in Bellene-1 (semievergreen forest) of Bellene state forest and Majagalale (evergreen forest) with 62.5 and 64 respectively. Again most of the moist deciduous forests have lower PEn as low as 3.7 in Munglimane-2 and 5.3 in Kelaginamane.

Diversity, dominance, evenness and Important Value Index (IVI) : Thekale has the highest species richness of 6.82 with 34 tree species in the entire transect. The Shannon diversity is high (3.13) in Kadagod with species richness of 6.75 and lowest dominance of 0.05. This is corroborated by High Simpson diversity and Pielou's evenness. 6 localities (27%) have a Shannon value of less than 2.5 indicating a lesser diversity compared to the other localities. However, the two moist deciduous patches Jambehalli and Kelaginamane have lower Shannon value

Table 2

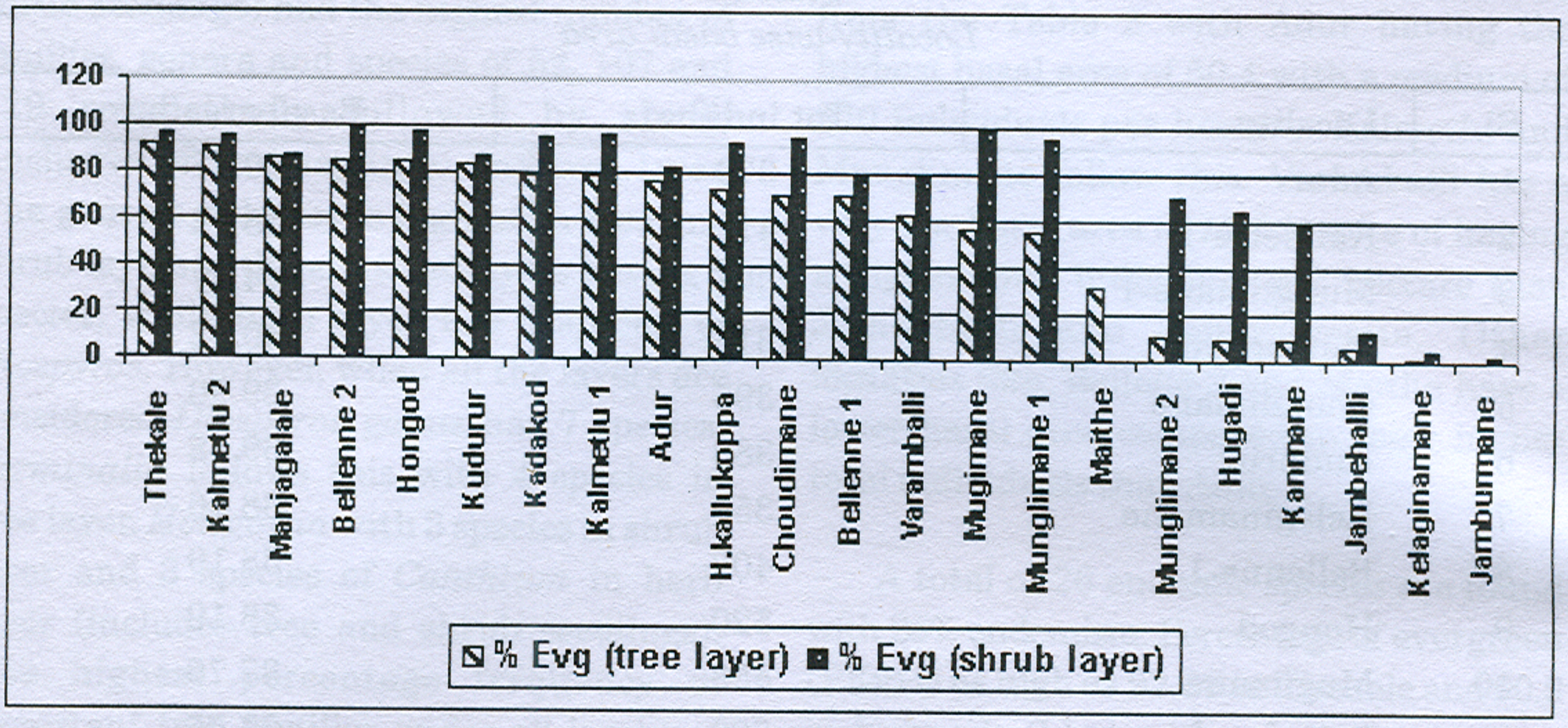
Locality-wise basal area

Sl	Locality	Tot ind/(ha)	Basal area(ha)
1	Adur	370	50.47
2	Kalmetlu-1	413	45.14
3	Munglimane-1	394	44.57
4	Manjagalale	313	40.42
5	Choudimane	395	39.90
6	Kudurur	388	39.68
7	Kelaginamane	356	38.46
8	Bellenne-1	400	38.19
9	Hongod	520	38.19
10	Mugimane	458	37.70
11	Bellenne-2	500	37.65
12	Kalmetlu-2	413	34.41
13	H.kallukoppa	283	32.68
14	Kanmane	305	31.61
15	Hugadi	305	31.34
16	Kadakod	425	29.80
17	Jambehallli	206	26.25
18	Munglimane-2	338	25.75
19	Maithe	488	25.47
20	Thekale	394	24.50
21	Jamburmane	188	16.10
22	Varamballi	255	15.60

of 1.5 (Table 3). 11 localities (50%) have a better diversity of more than 2.5 but less than 3. Five localities (22%) have a fairly high diversity of more than 3 but less than 3.13 (Kalmetlu, Choudimane, Kadagod, Munglimane-1 and Varamballi). Localities having the highest diversity (e.g. Kadagod) are also having the lowest dominance of 0.05 as shown by Simpson dominance. Kelaginamane a moist deciduous patch having the lowest diversity (1.5) has the highest dominance (0.32) with lowest evenness of 0.67 (Pielou's evenness value). Except Jambehalli showing low evenness of 0.71 other localities show evenness value of more than 0.8.

The Important Value Index (IVI) of 140.4 in Jambehalli and 114.2 in Kelaginamane show *Xylia xylocarpa* species dominating these localities (Table 4). Hence, they have lowest evenness values. *Terminalia paniculata* and *Olea dioca* are the most common species occurring in 4

Fig. 2



Percentage evergreen in Tree and Shrub layer

localities each with highest IVI. *Xylia xylocarpa* dominates in 3 localities. For each 3 species IVI is high in 2 localities and other 5 species have high IVI in only one locality each (Table 5).

Shrub layer : PEv was calculated considering only the tree saplings in shrub layer. The PEv was more in shrub layer compared to tree layer in most of the localities showing that the forests are still supporting good regeneration of evergreens. Highest PEv was seen in Mugimane and Bellene-2 with only evergreen tree saplings with no deciduous species (Figure 2). In 13 localities PEv was more than 80 % compared to 6 in tree layer. In deciduous forests of Jamburmane, Kelaginamane and Jambehalli the PEv is less than 15 %. In Maithe there are no evergreen juveniles compared to 32 % PEv in tree layer. Percentage endemism and diversity was calculated for shrub layer, which included all shrubs and tree saplings. Results show that 17 localities of tree layer had more PEn than shrub layer (5 localities) (Figure 3). This shows that though the regeneration of evergreens is high in shrub layer, most of them are nonendemics and hardy evergreen species. In Jamburmane, Kelaginamane, Jambehalli and Maithe both the PEv and diversity are very less. Except in Varamballi, Kalmetlu, Munglimane-2 and Jambehalli, tree layer has a higher Shannon diversity compared to shrub layer (Figure 4). This may be due to high dominance of some shrubs such as *Psycotria flavida, Eupatorium sp, Dichapetalum gelonoides* etc. in shrub layer. As seen from Fig. 5, diversity decreases as dominance increases with highest dominance in Bellene-2.

Herb Layer : Herb layer consisting of tree seedlings, shrub seedlings and other herb species shows a richer diversity compared to tree or shrub layer. 17 localities have more than 2.5 Shannon diversity compared to

Table 3

Diversity in different localities-Tree layer

Sl	Locality	Sps.richness	H'	sim-dom	D	Pielou
1	Varamballi	6.358	3.045	0.059	0.941	0.934
2	Kalmetlu-1	6.206	3.079	0.058	0.942	0.934
3	Munglimane-1	6.517	3.079	0.058	0.942	0.924
4	Mugimane	5.989	2.961	0.066	0.934	0.920
5	Kadakod	6.753	3.134	0.054	0.946	0.913
6	Bellenne-2	4.066	2.518	0.105	0.895	0.908
7	Choudimane	6.408	3.052	0.060	0.940	0.906
8	Adur	5.808	2.943	0.067	0.933	0.903
9	Maithe	4.591	2.746	0.082	0.918	0.902
10	Bellenne-1	5.530	2.863	0.072	0.928	0.901
11	H.kallukoppa	4.821	2.604	0.099	0.901	0.901
12	Kalmetlu-2	4.290	2.481	0.113	0.887	0.895
13	Manjagalale	4.601	2.603	0.098	0.902	0.884
14	Munglimane-2	3.034	2.082	0.169	0.831	0.868
15	Hugadi	4.865	2.604	0.112	0.888	0.855
16	Kudurur	4.846	2.603	0.107	0.893	0.855
17	Jamburmane	3.152	2.125	0.157	0.843	0.828
18	Kanmane	3.649	2.274	0.145	0.855	0.820
19	Hongod	6.029	2.749	0.108	0.892	0.817
20	Thekale	6.823	2.852	0.098	0.902	0.809
21	Jambehallli	2.288	1.569	0.315	0.685	0.714
22	Kelaginamane	2.226	1.556	0.321	0.679	0.676

Note: H' = Shanon Weiner diversity index, D: Simpson diversity index.

tree layer with 16 localities and 7 localities in shrub layer. Mugimane has the highest Shannon and Simpson diversities and lowest Simpson dominance. Evenness value is also high, next to Munglimane-2 (Table 6).

Discussion

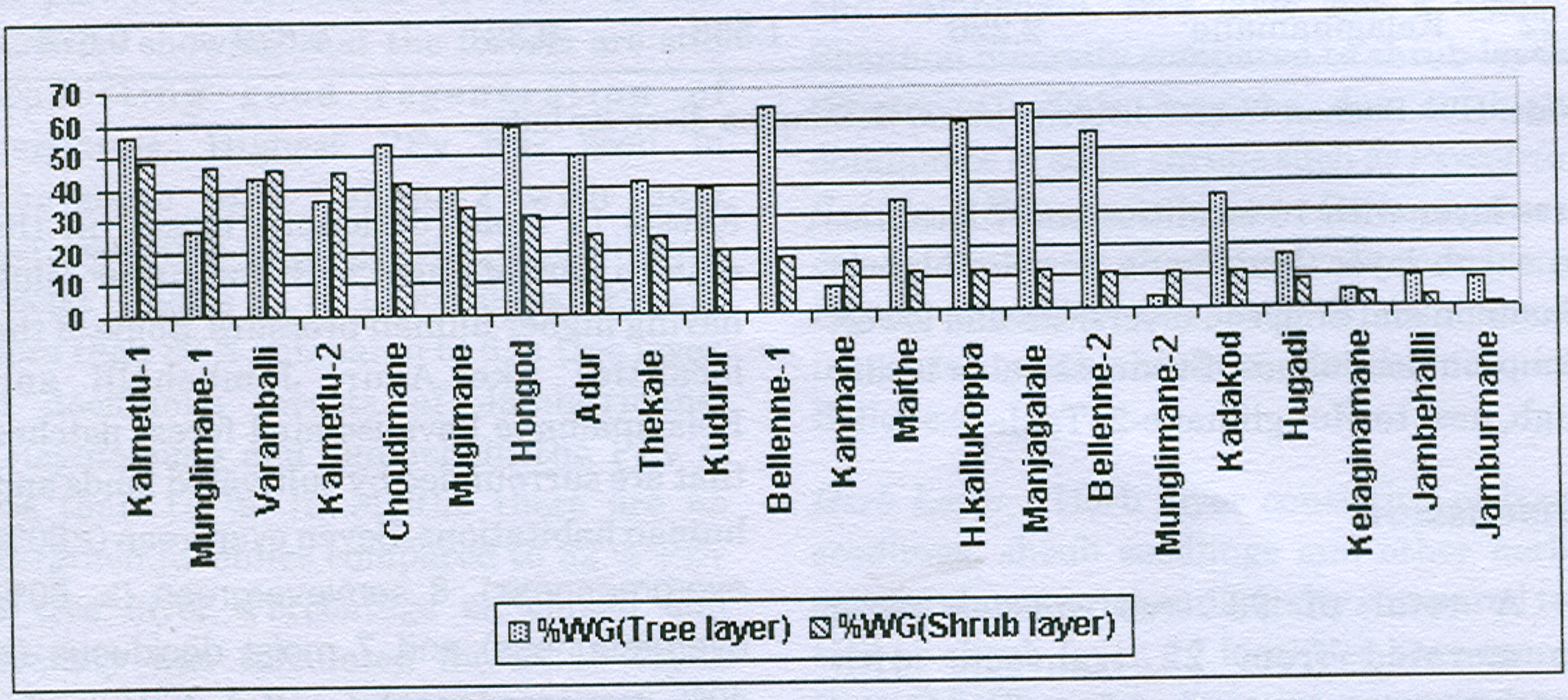
A total of 93 tree species were enumerated from 22 transects with vegetation type ranging from evergreen forests to moist deciduous mostly in the eastern part of Sagar and Hosanagar taluk having higher human pressure. Some of the localities like Adur, Jambehalli and Kelaginamane have isolated forest patches that are surrounded by cultivated lands and human habitations. Seven evergreen (≥80% evergreenness), 8 semievergreen (≥ 60% evergreenness) and 7 moist deciduous (≥ 40% evergreenness) forest habitats were

Table 4

Trees with highest Important Value Index (IVI) in different localities

Sl	Locality	Species	IVI	Pielou
1	Jambehallli	*Xylia xylocarpa*	140.37	0.714
2	Kelaginamane	*Xylia xylocarpa*	114.25	0.676
3	Kalmetlu-2	*Lophopetalum wightianum*	87.94	0.895
4	Jamburmane	*Terminalia paniculata*	67.65	0.828
5	Munglimane-2	*Terminalia paniculata*	65.51	0.868
6	Kudurur	*Olea dioca*	59.16	0.855
7	Hugadi	*Xylia xylocarpa*	58.92	0.855
8	Kanmane	*Terminalia paniculata*	58.38	0.820
9	Bellenne-2	*Olea dioca*	55.07	0.908
10	Bellenne-1	*Lagerstroemia lanceolata*	51.39	0.901
11	Hongod	*Aglaia anamallayana*	51.34	0.817
12	Kalmetlu-1	*Lophopetalum wightianum*	48.07	0.934
13	Thekale	*Aglaia anamallayana*	47.91	0.809
14	Manjagalale	*Canarium strictum*	47.25	0.884
15	Maithe	*Terminalia paniculata*	47.09	0.902
16	Choudimane	*Diospyros assymilis*	40.07	0.906
17	Munglimane-1	*Olea dioca*	39.06	0.924
18	H.kallukoppa	*Artocarpus hirsutus*	38.55	0.901
19	Mugimane	*Holigarna annottiana*	34.97	0.920
20	Varamballi	*Artocarpus hirsutus*	31.30	0.934
21	Adur	*Mimosops elengi*	30.58	0.903
22	Kadakod	*Olea dioca*	23.82	0.913

Fig. 3



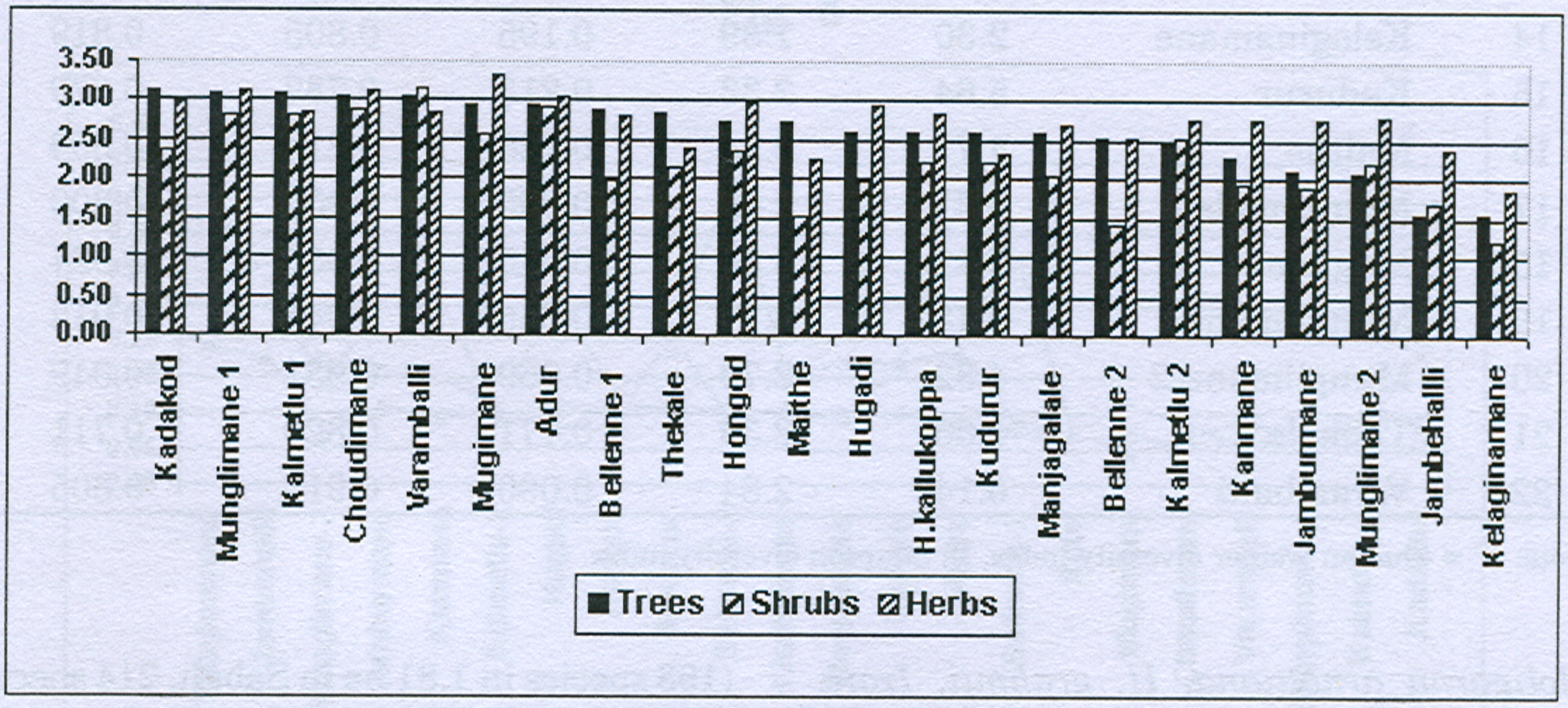
Percentage Endemism of Tree and Shrub layer in different localities

Table 5

Number of localities having same species with highest IVI

Sl.No	Species	Localities
1	*Terminalia paniculata*	4
2	*Olea dioca*	4
3	*Xylia xylocarpa*	3
4	*Lophopetalum wightianum*	2
5	*Artocarpus hirsutus*	2
6	*Aglaia anamallayana*	2
7	*Mimosops elengi*	1
8	*Lagerstroemia lanceolata*	1
9	*Holigarna annottiana*	1
10	*Diospyros assymilis*	1
11	*Canarium strictum*	1

Fig. 4



Shannon-Weiner's diversity index for tree, shrub and herb layers.

studied. Except in Kudurur, Thekale, Hongod, Choudimane, Manjagalale, Bellene and Kalmetlu in all other places the opened areas are being slowly overgrown by the common weed *Eupatorium divergens*. Some of the common species observed in more than six localities were *Actinodaphne hookeri*, *Aglaia anamallayana*, *Aporosa lindleyana*, *Cinnamomum macrocarpum*, *Diospyros assimilis*, *Diospyros candolleana*, *Canarium strictum*, *Knema attenuata*, *Garcinia morella*, *G.cambogia*, *Alstonia scholaris*, *Artocarpus hirsutus*, *Mimosops elengi*, *Mangifera indica*, *Symplocos beddomii*, *Syzigium* Sp, *Ficus* Sp.,

Table 6

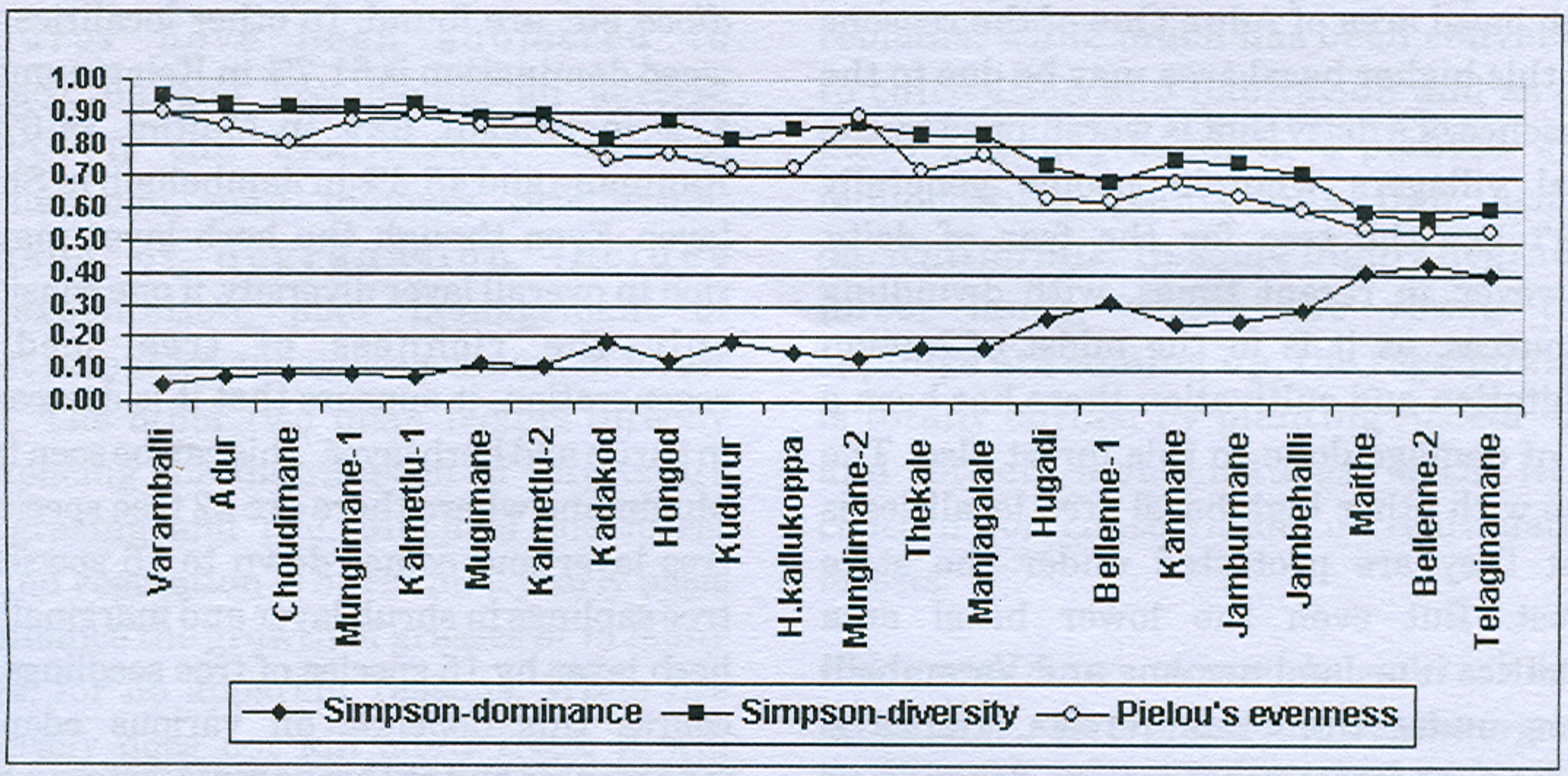
Species richness, H', D, Simpson dominance and Pielou's evenness for herb layer

Sl	Locality	Sps.rich	H'	Sim dom	D	Pielou
1	Adur	7.56	3.06	0.073	0.927	0.813
2	Bellenne-1	5.44	2.79	0.089	0.911	0.858
3	Bellenne-2	3.85	2.53	0.095	0.905	0.914
4	Choudimane	6.77	3.12	0.067	0.933	0.871
5	H.kallukoppa	7.67	2.84	0.108	0.892	0.743
6	Hongod	6.49	3.00	0.078	0.922	0.850
7	Hugadi	6.28	2.94	0.079	0.921	0.840
8	Jambehallli	6.17	2.38	0.178	0.822	0.664
9	Jamburmane	5.89	2.76	0.108	0.892	0.769
10	Kadakod	7.68	2.97	0.088	0.912	0.789
11	Kalmetlu-1	6.37	2.84	0.102	0.898	0.834
12	Kalmetlu-2	5.77	2.78	0.093	0.907	0.898
13	Kanmane	5.12	2.76	0.093	0.907	0.821
14	Kelaginamane	2.30	1.89	0.195	0.805	0.819
15	Kudurur	5.64	2.33	0.213	0.787	0.679
16	Maithe	4.77	2.24	0.186	0.814	0.659
17	Manjagalale	5.31	2.69	0.095	0.905	0.809
18	Mugimane	7.41	3.34	0.045	0.955	0.924
19	Munglimane-1	6.43	3.11	0.056	0.944	0.913
20	Munglimane-2	4.82	2.79	0.069	0.931	0.949
21	Thekale	4.86	2.39	0.171	0.829	0.711
22	Varamballi	6.14	2.84	0.090	0.910	0.805

Note: H' = Shanon Weiner diversity index, D: Simpson diversity index.

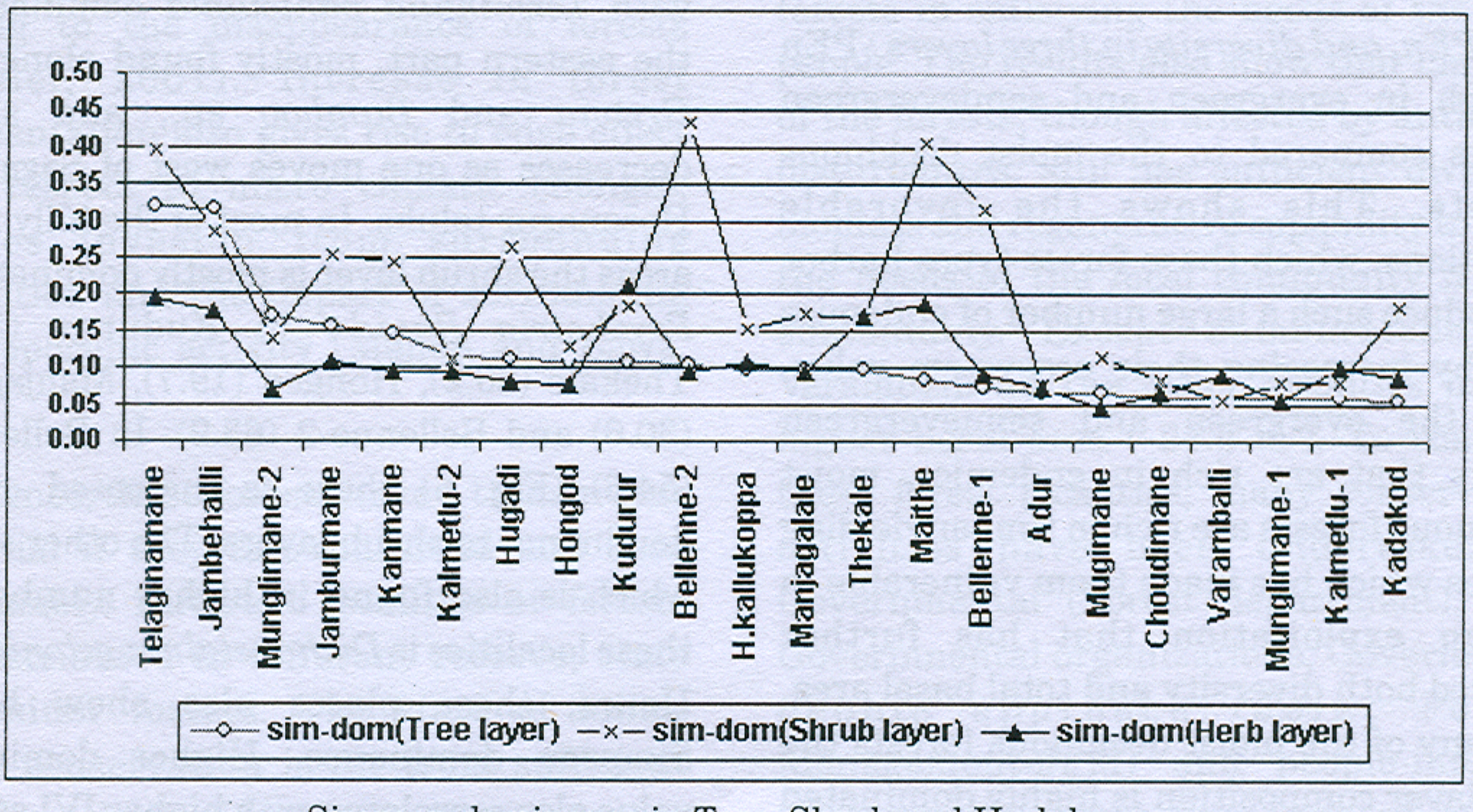
Holigarna arnottiana, H. grahmii, Ixora parviflora, Lagerstroemia microcarpa, Olea dioca, Macaranga peltata etc. These were common species in evergreen and semievergreen forests and *Xylia xylocarpa, Grewia* sp, *Terminalia* Sp, *Diospyros montana* etc. along with *Bambusas s*p. were common species observed in moist deciduous forests. The floristic richness is not very high for tree diversity (94 species) compared to data for trees c. 30 cm in Asia (198 species in 1.81 ha in Sabah, 214 species in 1 ha in Saravak and 244 species in 2 ha in Malaysia), but closer to the values obtained in some African forests (50 species in 4.05 ha in Nigeria and 120 species in 2 ha in Ghana) (Kessler, 2001). Considering the PEn for trees for entire locality 25 with total endemics of 26 species, it is not so high compared to other studies done in Western Ghats in the endemism pattern of southern Western Ghats (Pascal and Pellisier, 1996).

Fig. 5



Simpson's Diversity, Dominance and Pielou's Evenness for shrub layer

Fig. 6



Simpson dominance in Tree, Shrub and Herb layers

Endemics represented 48% of the total number of tree species, placing this forest in an intermediate position and endemism could be as high as 63% (for trees 10 cm DBH). The species number increases from tree layer to herb layer, which may be due to the addition of tree saplings in shrub layer (along with shrubs) and tree and shrub seedlings in herb layer (along with herbs).

Basal area : Species like *Mimusops elengi, Diospyros crumenata, Holigarna arnottiana*

and many *Ficus sp*. have contributed to the high basal area of Adur. One of the reasons for this higher basal area may be due to the presence of a deity that is worshipped by the local villagers wherein people generally don't axe the tree for the fear of deity. However, in recent times, with dwindling resources, as it is in the midst of human habitation and cultivation there has been a lot of damage done to this forest also. The case with other high basal area localities is that they are protected under the state forest. But even the lower basal area localities like Jamburmane and Varamballi come under the State forests. Hence it seems that forest conservation depends on the 'extent' of protection provided by both the forest department and the local people.

PEv, PEn, and diversity in three layers : PEn is high in evergreen and semievergreen forests compared to the moist deciduous forests. This shows the favorable conditions, which these forest types harbor to produce such a large number of endemics thereby increasing their ecosystem value. Like the evergreen and semievergreen forests that are rich in endemics, moist deciduous forests are rich in timber yielding species which has made them vulnerable to human exploitation that has further reduced both diversity and total basal area. In many of the moist deciduous forests the herb layer composition is highly dominated by the weed *Eupatorium divergens,* which starts encroaching the forest where there is large scale destruction and openings. This weed domination is as high as 35% in Maithe under herb layer with no seedlings of evergreen trees regenerating. However, in tree layers, species such as *Litsea* sp., *Knema attenuata, Memycelon talbotii, Olea dioca* etc. are found. In other localities this weed domination is 51.7% in Kelaginamane, 47% in Hugadi, 62% in Maithe, 44.6% in Kanmane and 45.3% in Jambehalli in Shrub layer. Even though the herb layer may be rich in overall layer diversity, if one considers only the richness of tree seedling regeneration, it appears that it is decreasing in shrub and herb layer. This can be seen from Mugimane where there are 22 tree species in tree layer and comes down to 16 species of tree saplings in shrub layer and marginally in herb layer by 15 species of tree seedlings. Of course this depends on various edaphic, topographic and anthropogenic factors where the last one may be more important. In most of the deciduous forests *Xylia xylocarpa* along with *Terminalia paniculata* dominates in the eastern part, mostly found along with *Grewia* and *Bamboo* sp., and slowly decreases as one moves west of Sagar and Hosanagar taluks. In most of the hilly forest areas the shrub layer is mostly dominated by *Psychotria flavida* in Kudurur (37.5), Thekale (30.2), Hongod (19.7), Manjagalale (30.6) and Bellenne-2 (63.9). In Bellenne-1 (54.6) (Fig. 6) there is increased overall dominance of shrub layers. The other shrub, which is also found in higher numbers in these localities is *Dichapetalum gelonioides.* Hence, these places also show higher Simpson dominance. Higher dominance value also correlates with higher IVI as seen for *Xylia xylocarpa, Terminalia paniculata* and other species. However, these also come under the preferred species for fuel and timber wood species.

Conservation and sustainable utilization : Most of the forests in the localities (ranging

from 574 ha in Adur to 3395.3 ha in Kudurur have been subjected to degradation and loss having an adverse effect on the biodiversity, natural regeneration, and biomass production. Causes of degradation include overexploitation, poor management of forest resources and encroachment of forest land. The other two main factors directly influencing the distribution of forests are overgrazing and fire. Much of the forest ground vegetation is burnt on a yearly basis to enhance the growth of grasses or in many cases, for no apparent reasons. While fire generally does not kill adult trees, it will effectively destroy the seedlings and young trees, thus preventing tree regeneration, creating senescent forests and eventually leading to the disappearance of forests (Kessler, 2001). Increase in forest fragmentation also gives rise to edge effect with respect to micro climatic changes, species invasion from surrounding vegetation and the impact of surrounding anthropogenic activity (Menon and Bawa, 1997).

Hence, these forests have a tremendous potential if they are conserved and used sustainably. Different localities or forests are distributed in different reserve, state and minor forests. The state of minor forest conservation is far from sufficient and the plight of localities coming under reserve and state forests is also bad due to rampant logging. Cotton and other crop cultivators are fast encroaching localities like Telaginamane (Telaginamane State forest), Jamballi (Jamballi State forest) and many other State forests. The former locality (Jamballi SF) is so degraded that only little of the original vegetation remains, while much has been converted to cultivation and habitation and as the place gets degraded, it is planted with monoculture plantations like *Acacia auriculiformis*. In some highly degraded forest lands, where the young tree saplings are coming up, the regeneration is totally curbed by planting *Acacia* spp. and other monocultures with little concern for conservation of rejuvenating forests.

Conservation through sustainable utilization : Evergreen and semievergreen forests are to be conserved not only for their ecosystem value with rich endemic species, but also because they couple with deciduous forests in satisfying the needs of the local people. The results also show that majority of the forests, though affected by anthropic disturbances, still has sufficient diversity, biomass and regenerative capability to cater the needs of the local community if used sustainably. Except Jamburmane and Varamballi all the other localities have a higher basal area (24.5 m^2). To conserve these forest localities, many conservation activities have been undertaken by Governmental (Forest department), non-Governmental organizations, Government-people approach (Joint Forest Management-JFM) and people-initiated "Community forest management system (CFMs)" strategies to save these flora and fauna. In most localities though the forest department is working for the protection of forests, their service is hampered by not being people-participatory, lack of local people's confidence, limited staff and resources and lower salutary returns to

local communities. The role of most of the Village Forest Committee's is increasing and can contribute more actively if their demands are met more efficiently and in time. People representation will be more if the forest department considers the local people or VFC for collecting NTFP of their villages and share the profit to each house hold members. For example, the upper Sharavathi catchment has nearly 23 VFC's which can be given the sole rights for NTFP collections. Here, each villager will have the right to collect NTFP from the buffer zones and sell it to VFC. In turn VFC's market these NTFP's outside sharing the profit with the forest department. This villager-based approach can be carried out instead of collections done by tenders given to non-localites by forest department. This approach will be more appealing since each villager will become more responsible for conserving the forests by which he is directly benefited and knows that if one tree is felled, he will be losing financial gains through NTFP. However, the highly fragile areas of forests which act as feeders to the numerous streams should be demarcated as core areas and protected from any kind of human activities. These forests not only help in acting as a focal point for dissemination of seeds for forest regeneration and as food for wild animals but also as watershed areas to keep the streams flowing throughout the year. This management strategy has to be meticulously and scientifically planned involving various experts from various fields and organizations including local communities. In case of isolated patches such as Adur, Kanmane etc., they can be more efficiently managed if the local VFC's or village communities work upon an efficient way of deriving the forest resources sustainably and thereby conserving their valuable forest. For this:

- They have to cut down the intensity of grazing inside the forest either by banning grazing for initial 5 years and later introducing regulated grazing periods in demarcated areas.
- Create broad trenches to keep away cattle.
- Protect the forest from fire, promoting normal regeneration.
- Discontinue the non-sustainable removal of either timber or fuel wood and implement regulated extraction of these resources. This can be done by permitting collection on selected days or extraction of fixed quantity of firewood per household in selected species (non-destructive collection) and ban on those trees used for higher yielding NTFP collections.
- Maximize the NTFP collection without affecting the regeneration of the forest so that the local communities get higher incentives and thereby help their financial situation, which has a positive effect on forest conservation.
- Decrease the pressure on the forest resources and the open eroded and barren lands planted with monoculture plantations initially and when the soil condition improves, replanted with mixed species plantations. These replanting has to be done taking into consideration the native vegetation

type, climate and topographic factors. People preferred local species to be planted in land supporting deciduous forests (e.g., Jambehalli) timber trees species such as *Grewia, Terminalia, Xylia, Dalbergia, Pterocarpus, Lagerstroemi, etc.*, NTFP yielding tree species such as *Diospyros melonoxylon, Spondias, Terminalia chebula, Cassia fistula, Emblica officinalis* etc., and to cater the needs of the local artisans like basket weavers etc. species of Bamboo and other soft wood tree species (for carving) etc.

- Finally the role of NGO's and Research organization could play a major role in promoting participatory forestry by catalyzing the rate of spread of JFM and CFM, community awareness of the policies of JFM, promote "cluster of villages" approach for protection and management under JFM and CFM (Kessler, 2001).

From this point of view, the present localities have several advantages: their higher basal areas, good native species regeneration (though there is increasing weed population) in high canopy disturbed evergreen and semievergreen localities, fair representation of VFC's and other conservation bodies and lastly growing environmental consciousness in people themselves. Thus, it would be possible to conserve and use the resources in a sustainable way if local communities and organizations start believing the concept of 'ecosystem conservation' instead of specific flora or faunal conservation.

SUMMARY

Changes in vegetation are taking place due to anthropogenic activities since the colonization of the evergreen forest zone of Western Ghats. The forests of the Western Ghats were contiguous and uniformly rich in endemism within each climatic and physiographic regime. The region continues to be one of the biodiversity hot spots of the world. However, unplanned developmental activities are altering the balance of the ecosystem. This study focuses on the floristic structure, composition and diversity of forests with varying degree of human disturbances. Based on the investigations, various strategies for conservation and sustainable utilization of forest resources were proposed.

Key words : **Plant diversity. Sharavathi River Basin, Sustainable utilization of forest resources, Western Ghats, Karnataka.**

मानव विघ्रों के संदर्भ में शरावती नदी पार की पादप विविधता

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सारांश

पश्चिमी घाट प्रदेश के सदाहरित वन क्षेत्र में मानव बसने लगने से ही मानव जनित क्रियाकलाप के कारण वहां की वनस्पतियों में परिवर्तन होने लग गए हैं। पश्चिमी घाट प्रदेश के वन अपने अपने जलवायु और भूरचनात्मक क्षेत्रों में एक दूसरे से सटे हुए और स्थान सीमितता में समान रूपेण सम्पन्न थे। यह क्षेत्र अभी भी विश्व के सक्रिय जैवविविधता वाले क्षेत्रों में बना हुआ है। परन्तु, अनियोजित विकास क्रियाकलाप यहां की परिस्थिति-संहति में परिवर्तन कर रहे है। प्रस्तुत अध्ययन में वहां का पादपीय संरचना और मानवों द्वारा डाले गए विघ्रों या विक्षोभ की विभिन्न मात्राओं से वन की रचना और विविधता पर ध्यान केन्द्रित किया गया है।

अन्वेषणों के आधार पर वन संसाधनों के संरक्षण और दीर्घकाल तक उनके टिकाऊ बने रहने वाले उपयोग की विभिन्न नीतियां भी प्रस्तावित की गई हैं।

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